MultiMux
Multiplexer

USER'S GUIDE

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1.1 Overview

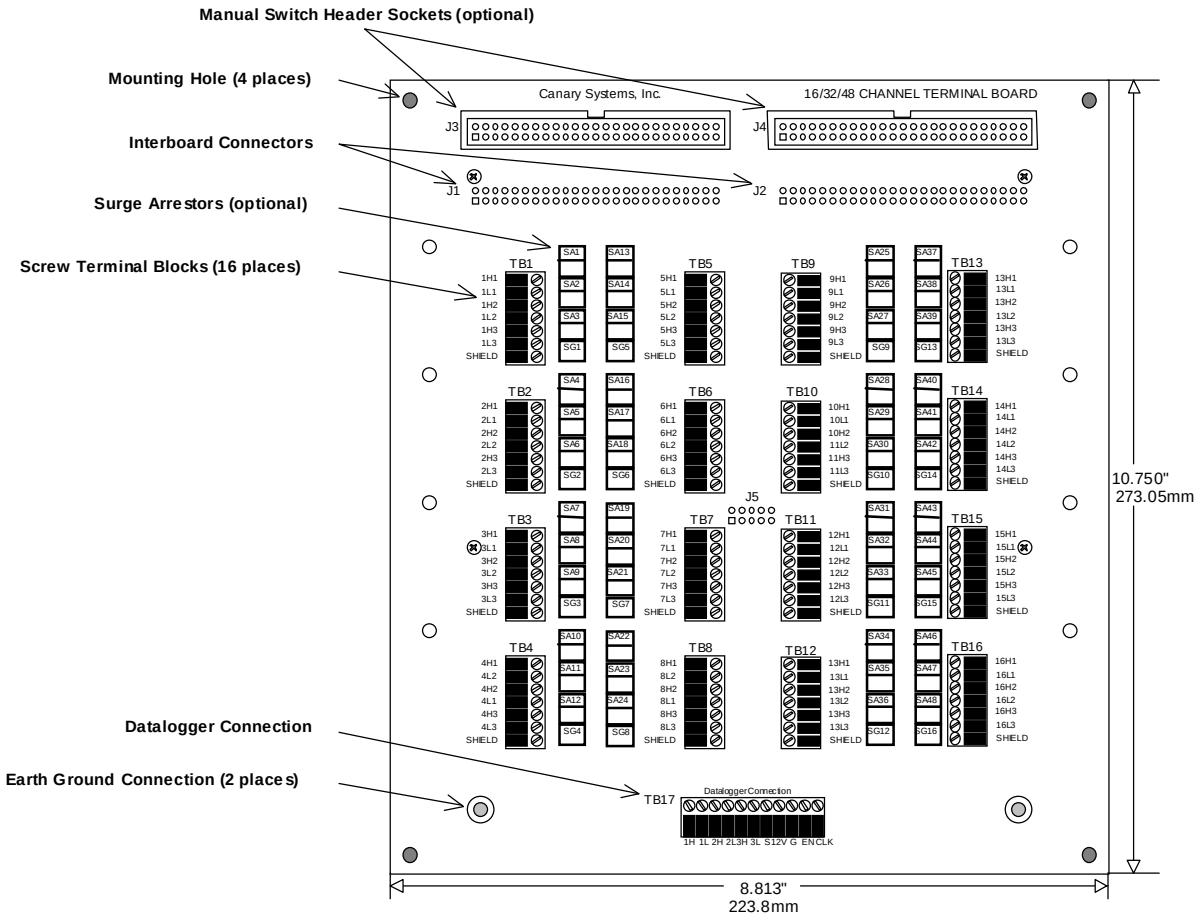
The MultiMux expands the number of instruments that may be read by the CR10 or CR10X in increments of 16, 32 or 48, depending on the model purchased and the type of sensor being read. In addition the MultiMux provides integral lightning protection by utilizing plasma surge arrestors (optional). The MultiMux may be purchased installed in a NEMA 4X fiberglass/polyester enclosure or as a board assembly for users supplying their own packaging.

The complete list of features and ordering options is detailed on the MultiMux Ordering Guide available from our web site or by contacting Canary Systems directly.

The MultiMux consists of two printed circuit boards (PCB's), one for making the instrument connections (the terminal board) and the second, installed on the back of the terminal board (the switch board), for switching the instrument leads. The MultiMux utilizes advanced high-reliability components such as terminal blocks from Phoenix Contact (**http://www.phoenixcontact.com**), relays from Aromat corporation (**http://www.aromat.com**) and a microcontroller from Microchip Devices (**http://www.microchip.com**) to help insure years of reliable and trouble-free operation. The use of low contact resistance relays means almost universal instrument support, a high degree of lightning protection and virtually infinite channel isolation.

Warranty is applicable for 2 years from date of shipment. Warranty does not cover failure by misuse or by nature including lightning, flood, or other catastrophe. Should you encounter problems with your MultiMux see the troubleshooting flowchart in section 3.

A top view and description of the MultiMux terminal board is shown below.



1.2 Specifications

General
Power requirements: 9-16 VDC (unregulated)
Quiescent current: 100 µA
Channel activated current (2 or 4-wire): 40 mA
Channel activated current (6-wire): 50 mA
Control line input impedance: 10 kilohms
Control line input levels: TTL or CMOS (5V logic)
Transient protection: 18 VDC, 1500W Transzorbs
Operating temperature: -40 to +70° C (-40 to +160° F)

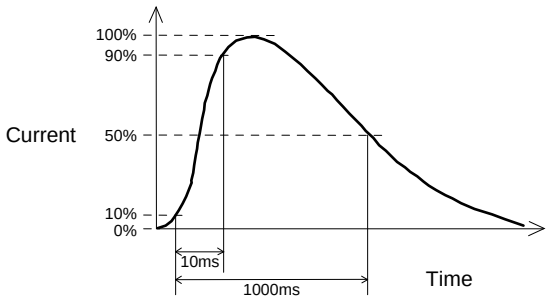
Relays
Power: 11 mA @ 12VDC (140 mW)
Contact type: Gold-clad silver alloy
Electrostatic capacitance: 3 picofarads
On resistance: 50 milliohms
Coil resistance: 1,028 ohms
Maximum switching voltage: 125 VAC, 110 VDC
Maximum switching power: 30 W (resistive load)
Maximum switching current: 1 A
Operate time: ~2 milliseconds
Release time: ~1 milliseconds
Initial contact bounce: ~1 millisecond
Surge withstand (between open contacts): 1,500 V
Switching life (mechanical): 100,000,000 operations

Lightning Protection Components (optional)

Tripolar Plasma Surge Arrestor (SA1-SA48)
Nominal DC breakdown voltage: 250 V
Surge life: 400 (10/1000 ms pulse @ 500 Amps)
Maximum surge current: 10 kA per side (8/20 µs pulse)
Insulation resistance: 10,000 Megohms

Bipolar Plasma Surge Arrestor (SG1-16)
Nominal DC breakdown voltage: 230 V
Surge life: 1,000 (10/1000 µs pulse @ 500 Amps)
Maximum surge current: 20 kA (8/20 µs pulse)
Insulation resistance: 10,000 Megohms

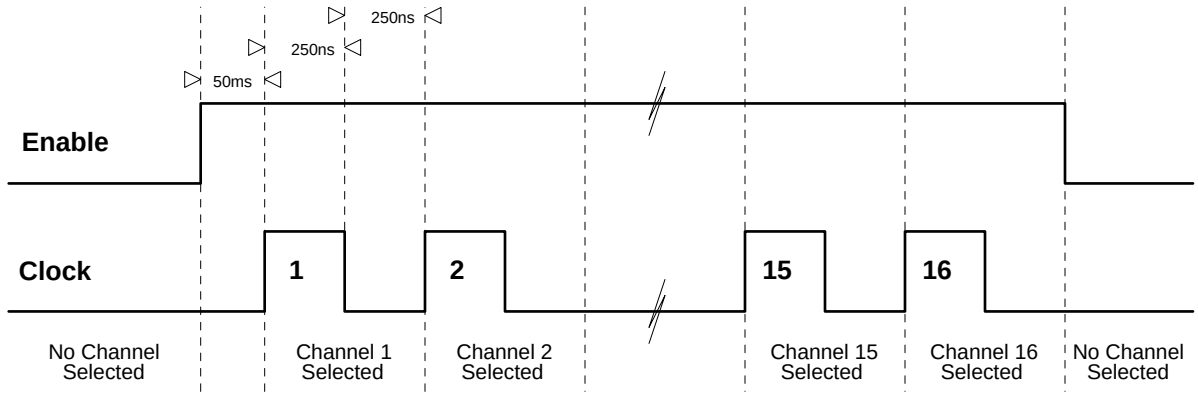
Surge Waveform



2.1 Operation Details

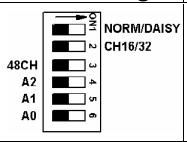
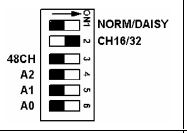
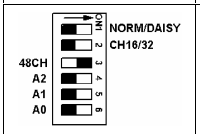
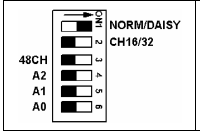
The MultiMux is controlled by the CR10 or CR10X Controller using 2 digital control signals. The operation of the MultiMux is simple enough so that virtually any device capable of controlling 2 digital TTL/CMOS type signals can be used to control the multiplexer. Generally speaking the timing diagram depicted below describes how the 2 digital signals are used to control the MultiMux.

Note: Timing values shown are minimum values.



In the case of the 32 or 48 channel modes the maximum number of pulses to advance through all the channels would be 32 and 48, respectively.

The channel switching mode is selected by configuring the DIP switch mounted on the MultiMux relay board (mounted under the terminal board). The table shown below describes the 4 possible configurations.

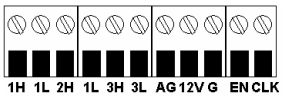
DIP Settings	Mode	Description
	***16 Channel***	***Standard mode for switching 4 or 6-wire instruments (default).***
	32 Channel	Switching 32 2-wire instruments.
	48 Channel	Switching 48 2-wire instruments (optional).
	DaisyMux	Mode where control signals are common to more than 1 multiplexer. See section 2.8 for more information on DaisyMux mode.

The factory default setting is 16 Channel mode (unless specified otherwise).

2.2 Datalogger Connection

The MultiMux is connected to the CR10/CR10X Controller or MultiLogger Mux Terminal Board (or ML MUX TB) using the screw terminals on the terminal board.

The screw terminal block located on the bottom of the terminal board has the following connections:



The table below lists the connections for the screw terminal block.

TB	ML MUX TB Connection	Description	Bendix	Mux Cable (5 pair)	Mux Cable (6 pair)
1H	**1H**	High side of CH1	A	White	Brown
1L	**1L**	Low side of CH1	B	White's Black	Brown's Black
2H	**2H**	High side of CH2	C	Red	Red
2L	**2L**	Low side of CH2	D	Red's Black	Red's Black
3H	**NC**	High side of CH3			White
3L	**NC**	Low side of CH3			White's Black
AG	**S**	Gage shield	E	Blue & Blue's Black	Blue & Blue's Black
12V	**12V**	Power	F	Yellow	Yellow
G	**GND**	Ground	G	Yellow's Black	Yellow's Black
EN	**EN**	Enable	H	Green	Green
CLK	**CLK**	Clock	J	Green's Black	Green's Black
	S	Cable Shield	K	Shield Wires from White & Red Pair plus Overall	Shield Wires from Brown & Red Pair plus Overall

If using the MultiSensor Interface with your CR10 or CR10X then connect from the 10-pin connector (using the supplied cable) on the Interface to the screw terminals of the MultiMux in the following order:

Pin	Color	Connection	Description
1	**Brown**	**1H**	Low side of CH1
2	**Red**	**1L**	High side of CH1
3	**Orange**	**2H**	Low side of CH2
4	**Yellow**	**2L**	High side of CH2
5	**Green**	**AG**	Gage shield
6	**Blue**	**12V**	Power
7	**Purple**	**G**	Ground
8	**Grey**	**EN**	Enable
9	**White**	**CLK**	Clock
10	**Black**	**Cable Shields**	Cable Shield

The MultiSensor Interface does not support the 6-wire switching capability of the MultiMux so the **3H** and **3L** terminals are not connected.

2.3 Instrument Connection

The way instruments are connected to the MultiMux will vary slightly depending on the Mode selection (section 2.1).

The following table illustrates typical connection techniques for each of the operating modes.

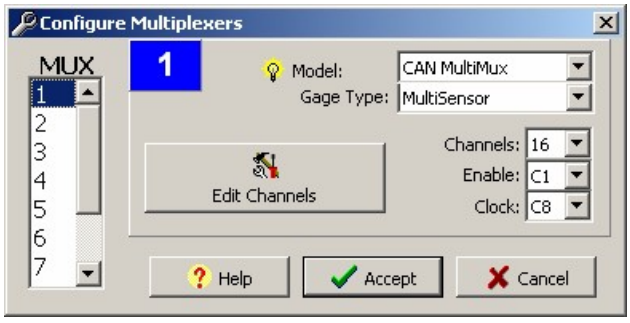
Mode	Description	Example
16 Channel (4-wire)	Instrument #1 < 1H1 1L1 Temperature for Instrument #1 < 1H2 1L2 No Connection < 1H3 1L3 SHIELD TB1	VW Gage #1 < 1H1 1L1 Thermistor in VW Gage #1 < 1H2 1L2 No Connection < 1H3 1L3 SHIELD TB1
32 Channel	Instrument #1 < 1H1 1L1 Instrument #2 < 1H2 1L2 No Connection < 1H3 1L3 SHIELD TB1	VW Gage #1 < 1H1 1L1 VW Gage #2 < 1H2 1L2 No Connection < 1H3 1L3 SHIELD TB1
48 Channel	Instrument #1 < 1H1 1L1 Instrument #2 < 1H2 1L2 Instrument #3 < 1H3 1L3 SHIELD TB1	VW Gage #1 < 1H1 1L1 VW Gage #2 < 1H2 1L2 VW Gage #3 < 1H3 1L3 SHIELD TB1
DaisyMux	Same as 16 Channel Mode	Same as 16 Channel Mode

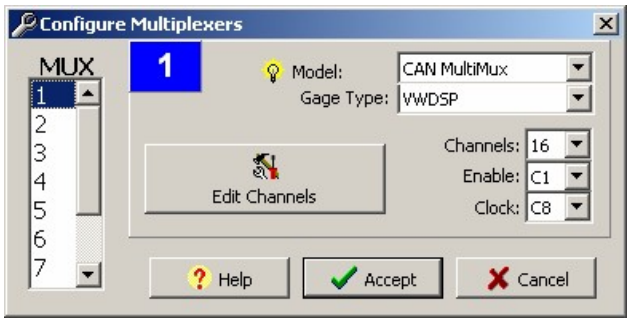
If the CR10 or CR10X is not equipped with the MultiSensor Interface see Appendix D of the **MultiLogger Software User's Guide** for sensor wiring diagrams. If the CR10 or CR10X is equipped with the MultiSensor Interface then see the **MultiSensor Interface User's Guide** for additional sensor wiring diagrams.

2.4 MultiLogger Software Configuration

To configure MultiLogger to use the MultiMux select **CAN MultiMux** as your multiplexer **Model** on the **Configure | Multiplexers** form. Before the individual channels may be edited you must select a **Gage Type**, if the MultiSensor Interface is being used then select MultiSensor, as shown in the illustration at right, otherwise the type of gage connected. Select either **16 Channels** (default), **32 Channels** or **48 Channels** to match the DIP switch settings of the MultiMux. The **Enable** and **Clock** port settings are generally ignored when **MultiSensor** is selected as the Gage Type, with the exception of using the **Enable** setting to determine DaisyMux configuration. See section 2.9 for more information on DaisyMux operation.

If the VWDSP Interface is being used (without the MultiSensor Interface) be sure to select the VWDSP Gage Type, as shown.





2.5 CR10/CR10X Program Example

The following example illustrates how to write custom programs for the CR10/CR10X to read instruments connected to the MultiMux. The example assumes a 16 Channel Mode MultiMux reading 16 vibrating wire gages and their respective thermistors.

The program example illustrates how measurements of instruments connected to the MultiMux are read, it does not include instructions that would store the measurements for later retrieval. Consult the CR10 Operators Manual for more information on storing measurements.

```
1:  Set Port(s) (P20) ;Configure the control ports of the CR10/CR10X, C1=Enable, C8=Clock
 1: 7999     C8..C5 = output/nc/nc/nc
 2: 9994     C4..C1 = nc/nc/nc/10ms

2:  Do (P86) ;Enable the MultiMux
 1: 41       Set Port 1 High

3:  Excitation with Delay (P22) ;50ms delay after enabling the MultiMux
 1: 1        Ex Channel
 2: 0        Delay W/Ex (units = 0.01 sec)
 3: 5        Delay After Ex (units = 0.01 sec)
 4: 0        mV Excitation

4:  Beginning of Loop (P87)
 1: 0        Delay
 2: 16       Loop Count ;Total number of instruments

5:  Do (P86) ;Advance the channel
 1: 78       Pulse Port 8

6:  Vibrating Wire (SE) (P28) ;Read the Vibrating Wire Gage
 1: 1        Reps
 2: 1        SE Channel
 3: 1        Excite all reps w/Exchan 1
 4: 20       Starting Freq. (units = 100 Hz)
 5: 35       End Freq. (units = 100 Hz)
 6: 250      No. of Cycles
 7: 0        Rep Delay (units = 0.01 sec)
 8: 1     -- Loc [ VWGage_1  ]
 9: 1000     Mult
10: 0        Offset

7:  Excite-Delay (SE) (P4) ;Read the Thermistor
 1: 1        Reps
 2: 5        2500 mV Slow Range
 3: 2        SE Channel
 4: 1        Excite all reps w/Exchan 1
 5: 5        Delay (units 0.01 sec)
 6: 2500     mV Excitation
 7: 17    -- Loc [ VWTemp_1  ]
 8: .001     Mult
 9: 0        Offset

8:  Polynomial (P55) ;Convert thermistor voltage to °C
 1: 1        Reps
 2: 17    -- X Loc [ VWTemp_1  ]
 3: 17    -- F(X) Loc [ VWTemp_1  ]
 4: -104.78  C0
 5: 378.11   C1
 6: -611.59  C2
 7: 544.27   C3
 8: -240.91  C4
 9: 43.089   C5

9:  End (P95) ;End of measurement loop
```

2.6 CR1000 Program Example

```
'Enable our multiplexer
PortSet (1,1)
'Wait 100mSec for multiplexer to power up
Delay(0,100,MSEC)
'Cycle through 16 channels
For Channel = 1 TO 16
'Set Clock port high to advance mux channel
PortSet(8,1)
'Wait 10mSec for 50% duty cycle
Delay(0,10,MSEC)
'Set Clock port low
PortSet(8,0)
'Wait 10mSec for channel to settle
Delay(0,10,MSEC)
'Read our vibrating wire gage
VibratingWire(MuxChannel(),1,mV7_5,2,VX1,600,3600,500,-1,20000,500,0,1,0)
'Read our YSI44005 type thermistor
BrHalf(ScratchLoc(1),1,mV2500,2,VX1,1,2500,0,1000,250,2.5,0.0)
ScratchLoc(2) = ScratchLoc(1) / 5000
ScratchLoc(3) = (2.5 - (ScratchLoc(2)*1000) - ScratchLoc(1))/ScratchLoc(2)
MuxChannelTemp() = 1/(.0014051 + (.0002369*Log(ScratchLoc(3))) +
(.0000001019*(Log(ScratchLoc(3))^3))) - 273.2
'End of measurement loop
Next
'Disable our multiplexer
PortSet (1,0)
```

2.7 CR1000 Program Example with VWDSP

See our Application Note #11 for more information on using the VWDSP Interface. This can be found in the Support area of our website at www.canarysystems.com

The VWDSP can also originate clocking pulses using it's own port – the example below uses C8 of the control module to provide clocking pulses.

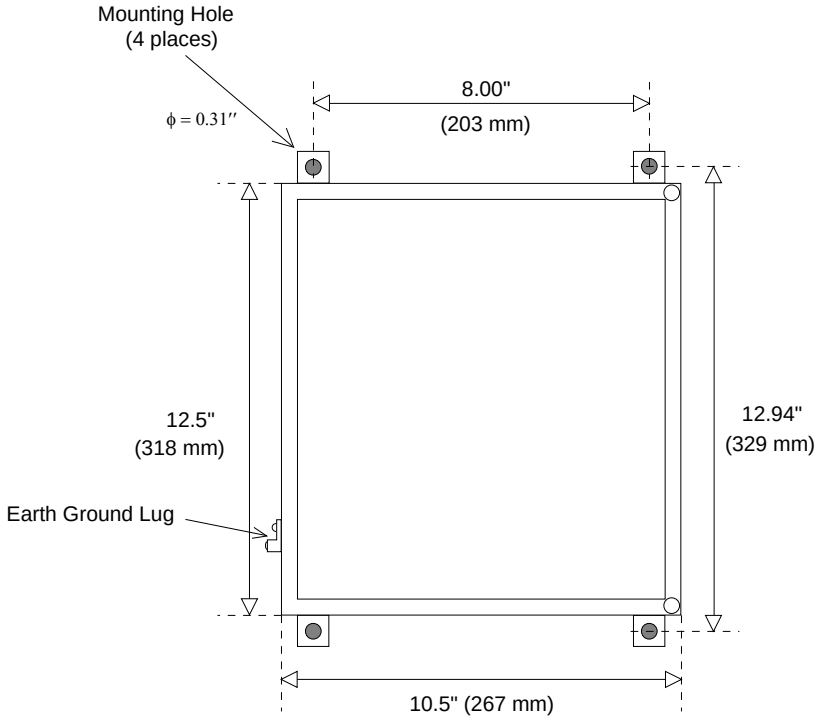
```
'Enable our VWDSP
PortSet (7,1)
'Wait 125mSec for VWDSP to power up
Delay(0,125,MSEC)
'Open our serial port for VWDSP Communication
SerialOpen (8,1200,0,1000,255)
'Enable multiplexer
SerialOut (8,"M1"+CHR(13),"",0,0)
'Wait 125mSec for multiplexer to power up
Delay(0,125,MSEC)
'Cycle through 16 channels
For Channel = 1 TO 16
'Set Clock port high to advance mux channel
PortSet(8,1)
'Wait 10mSec for 50% duty cycle
Delay(0,10,MSEC)
'Set Clock port low
PortSet(8,0)
'Wait 10mSec for channel to settle
Delay(0,10,MSEC)
'Read our vibrating wire gage using VWDSP
       'Short delay
       Delay (0,100,mSec)
       'Send P configuration command
```

```
        SerialOut (Com3,"P0400 3500 0600 0040 0300"+CHR(13),"",0,0)
        'Short delay
        Delay (0,200,mSec)
        'Clear buffer
        SerialFlush(Com3)
        'Send VA measurement command
        SerialOut (Com3,"VA"+CHR(13),"",0,0)
        'Configure serial input for receiving response
        SerialIn(sInBuf,Com3,1500,-1,30)
        'Check if enough characters received
        if Len(sInBuf) >= 30 then
                'Process response
                Splitstr(ScratchLoc(),sInBuf," ",4,0)
                'Convert to digits
                ScratchLoc(5) = 1/((((ScratchLoc(3) * 65536) +
        ScratchLoc(4))/ScratchLoc(2)) * 0.1356)
                ScratchLoc(5) = (ScratchLoc(5) * 1000000)^2
                ScratchLoc(5) = ScratchLoc(5) * 0.001
                MuxChannel() = ScratchLoc(5)  * 0.001
        Else
                'No VA command response
                MuxChannel() = -99.999
        EndIf
'Read our YSI44005 type thermistor using VWDSP
        'Short delay
        Delay(0,50,mSec)
        'Clear Buffer
        SerialFlush(Com3)
        'Send TA measurement command
        SerialOut (Com3,"TA"+CHR(13),"",0,0)
        'Receive response
        SerialIn(sInBuf,Com3,100,-1,18)
        'Check if enough characters received
        if Len(sInBuf) > 16 then
                'Process response
                Splitstr(ScratchLoc(),sInBuf," ",2,0)
                'Convert to degrees C (>= VWDSP FW version 8) using Steinhart-hart
                ScratchLoc(3) = ((ScratchLoc(1) * 65536) + ScratchLoc(2)) / 100
                ScratchLoc(4) = ((ScratchLoc(3)/1023)*2.5)
                ScratchLoc(5) = ScratchLoc(4) / 6040
                ScratchLoc(6) = ScratchLoc(5) * 499
                ScratchLoc(7) = (2.5 - ScratchLoc(4) - ScratchLoc(6)) / ScratchLoc(5)
                'Finish conversion
                MuxChannelTemp() = 1/(.0014051 + (.0002369*Log(ScratchLoc(7))) +
        (.0000001019*(Log(ScratchLoc(7))^3))) - 273.2
                'Check for error conditions
                if MuxChannelTemp() > 100 then MuxChannelTemp() = -99.8
        else
                'No response from VWDSP
                MuxChannelTemp() = -99.9
        endif
'End of measurement loop
Next
'Disable VWDSP
PortSet (7,0)
'Close our serial port for VWDSP communication
SerialClose (8)
```

2.8 Enclosure Installation

The standard enclosure for the MultiMux is a Hoffman 12x10 fiberglass/polyester NEMA 4 type. The enclosure can be mounted to a wall or other surface by attaching the 4 supplied mounting tabs to the bottom of the enclosure using the supplied screws.

The placement of the mounting holes is depicted in the illustration below.



2.9 Lightning Protection

If the MultiMux is equipped with the optional lightning protection components then care must be exercised in the installation to maximize their effectiveness. Specifically, an effective earth ground must be attached to the MultiMux terminal board.

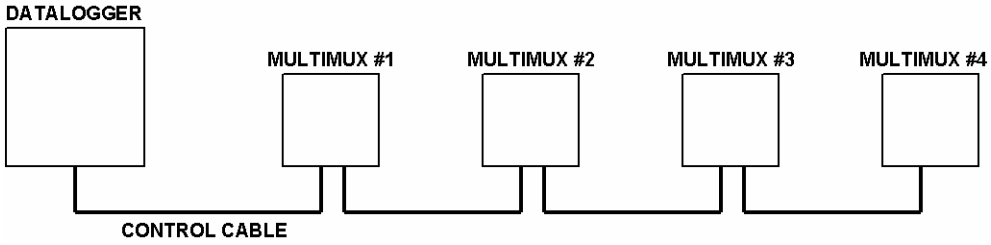
If the MultiMux was ordered in an enclosure with the lightning protection components then there will be a ground lug on the side of the enclosure as shown in the illustration above. Attach a large gauge copper wire (6-12 AWG) from the lug to a suitable earth ground, either a copper stake driven into the earth or a known electrical system earth ground.

Copper earth ground stakes and connecting wire are available from Canary Systems.

2.10 DaisyMux Operation

DaisyMux is a special operation mode where all of the signals are shared between 2 or more multiplexers. The MultiMux supports up to 8 multiplexers used in a DaisyMux configuration and the switching mode is ALWAYS 16 Channel.

The advantage with the DaisyMux configuration is that a single cable may be used to connect a string of MultiMux multiplexers together, as shown in the diagram below.



There are 2 configuration issues to deploy the DaisyMux, the DIP switch settings of the MultiMux and the MultiLogger Software configuration.

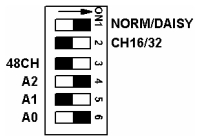
MultiMux DIP Switch Settings

On the MultiMux are 3 switches in the DIP switch array, labeled A2, A1 and A0, that control the address of the multiplexer, this address ranges between 0 and 7 in binary values, or between 1 and 8 in terms of the multiplexer number. These determine which section of channels will be activated, i.e. the MultiMux configured with address 0 with be active for channels 1-16, the MultiMux with address 1 will be active for channels 17-33, etc.

The following table illustrates the range multiplexer numbers and corresponding DIP switch settings.

Mux#	A2 – SW4	A1 – SW5	A0 – SW6
1	OFF	OFF	OFF
2	OFF	OFF	ON
3	OFF	ON	OFF
4	OFF	ON	ON
5	ON	OFF	OFF
6	ON	OFF	ON
7	ON	ON	OFF
8	ON	ON	ON

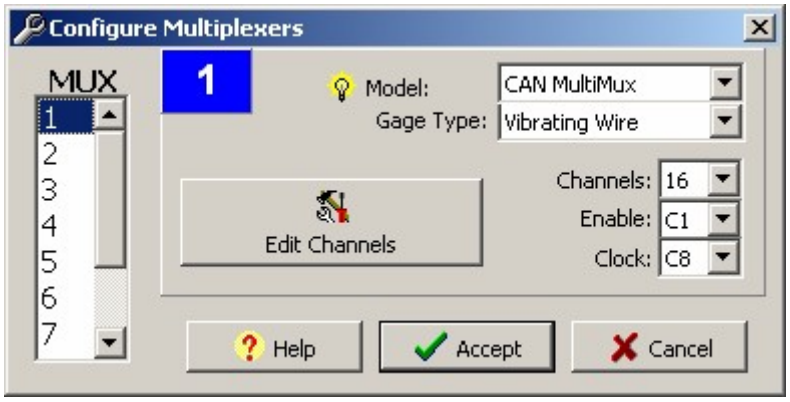
For example, the DIP switches for MultiMux #6 should be configured as shown:



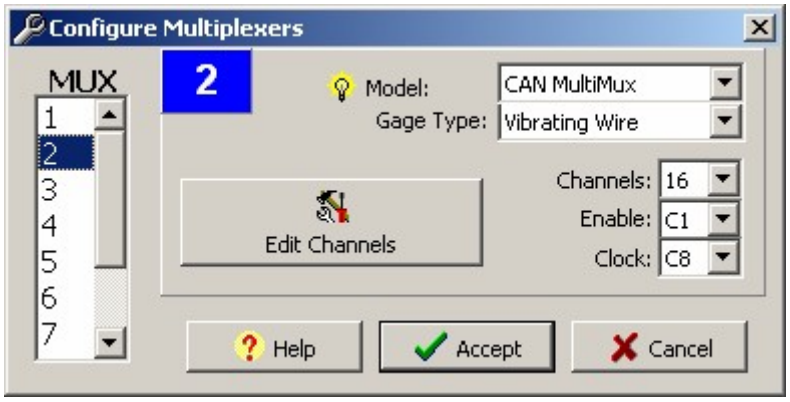
NOTE: ONLY 16 channel mode is supported by the DaisyMux!

MultiLogger Software Configuration

Multiplexers are configured using the **Program | Multiplexers** form, as illustrated.

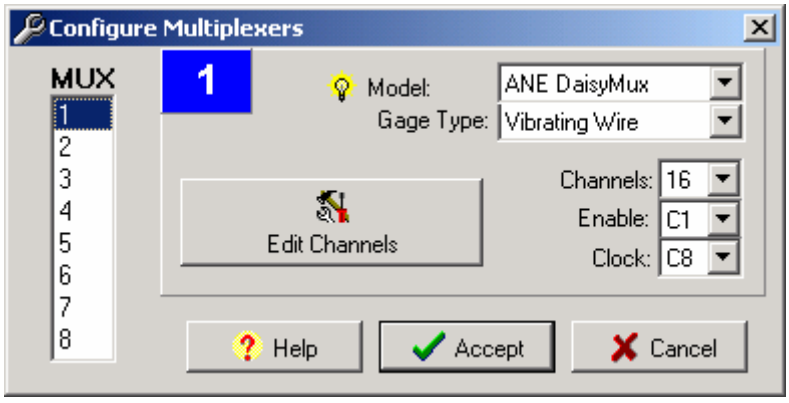


To configure DaisyMux operation you would simply specify an **Enable** port that matches all of the multiplexers in the series. For example, multiplexer #2 would be configured as shown below.



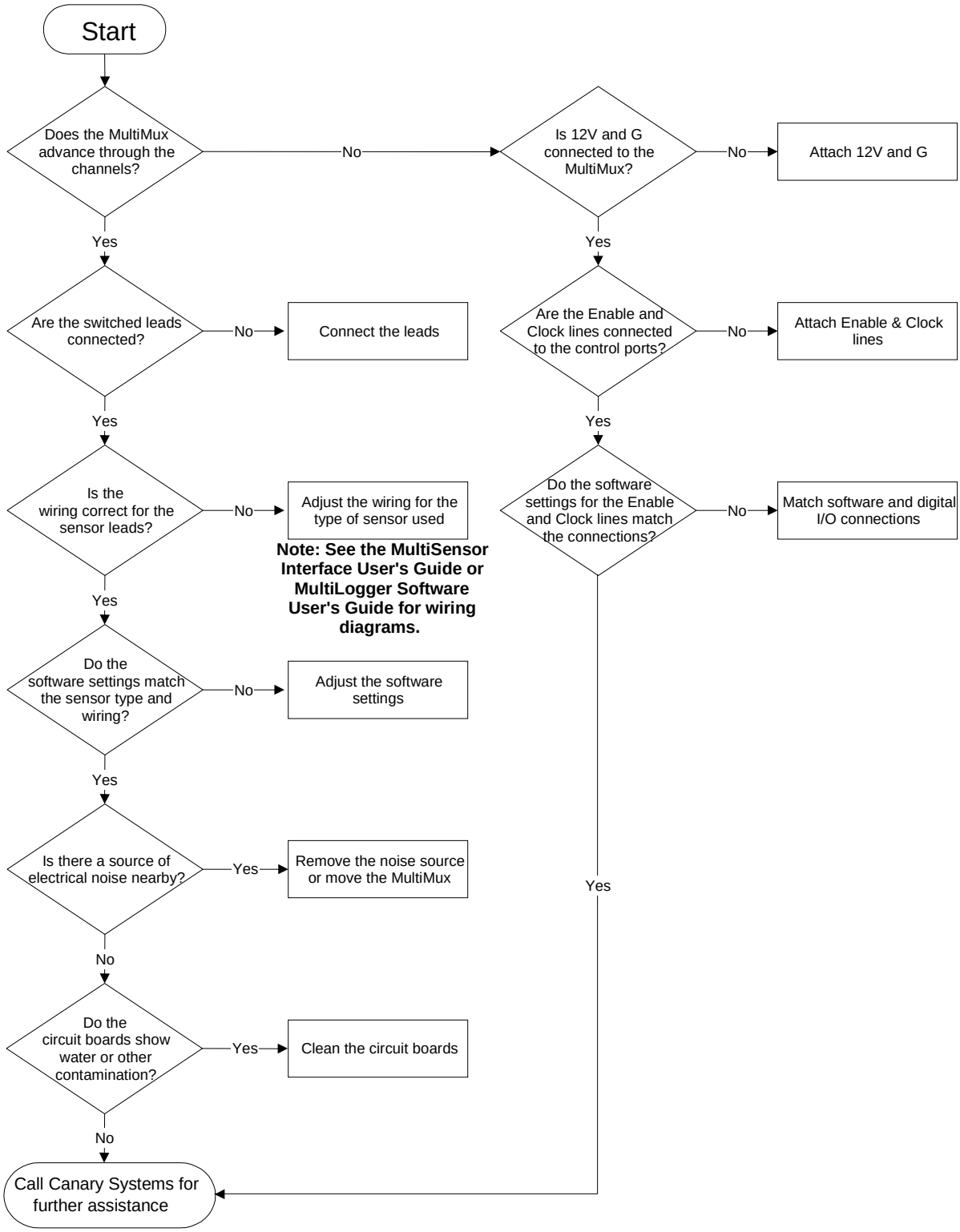
When MultiLogger builds the datalogger program it will note that the Enable setting is the same for the 2 (or more) multiplexers, it will not lower the **Enable** line, which would effectively reset the multiplexers, between the multiplexers.

NOTE: This functionality was supported beginning with version 2.1.1 of the MultiLogger Software. Prior to version 2.1.1 you were required to use the special ANE DaisyMux Model (as shown) to support the DaisyMux configuration. If your version of software is outdated it is recommended that you upgrade, contact Canary Systems or your software vendor to obtain the access information for software upgrades. Software upgrades are available through a support contract.



3.1 Troubleshooting Flowchart

If you cannot obtain readings using the MultiMux or the readings are unstable then see the troubleshooting flowchart below for help in determining the nature of the problem.


Start
Does the MultiMux advance through the channels?
No
Is 12V and G connected to the MultiMux?
No
Attach 12V and G
Yes
Yes
Are the switched leads connected?
No
Connect the leads
Are the Enable and Clock lines connected to the control ports?
No
Attach Enable & Clock lines
Yes
Yes
Is the wiring correct for the sensor leads?
No
Adjust the wiring for the type of sensor used
Note: See the MultiSensor Interface User's Guide or MultiLogger Software User's Guide for wiring diagrams.
Do the software settings for the Enable and Clock lines match the connections?
No
Match software and digital I/O connections
Yes
Yes
Do the software settings match the sensor type and wiring?
No
Adjust the software settings
Yes
Is there a source of electrical noise nearby?
Yes
Remove the noise source or move the MultiMux
Yes
No
Do the circuit boards show water or other contamination?
Yes
Clean the circuit boards
No
Call Canary Systems for further assistance